

# TES H<sub>2</sub>O Comparisons: AMSR-E, AIRS, MLS

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# Outline

- Dataset & analysis
- Total water vapor comparison with AMSR-E
- TES-AIRS water vapor comparisons
- Latitudinal dependence of statistics
- TES-MLS water vapor comparisons
- Conclusions

# The data sets

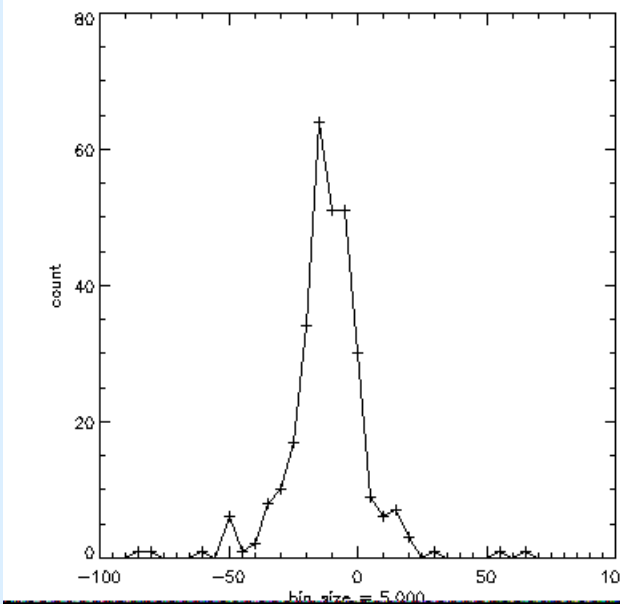
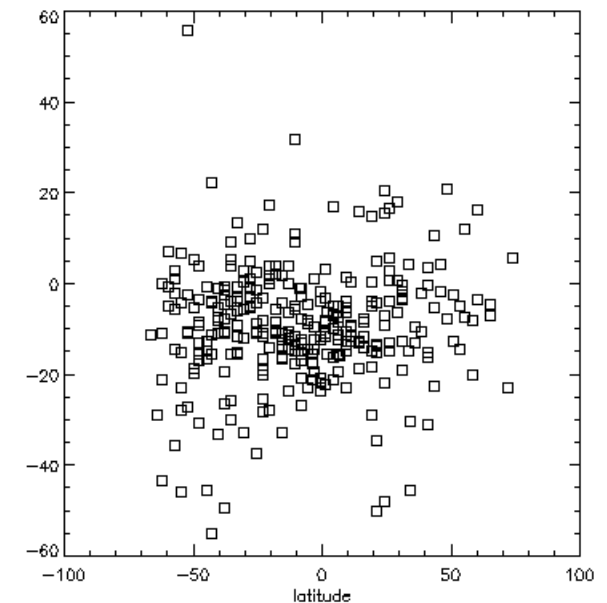
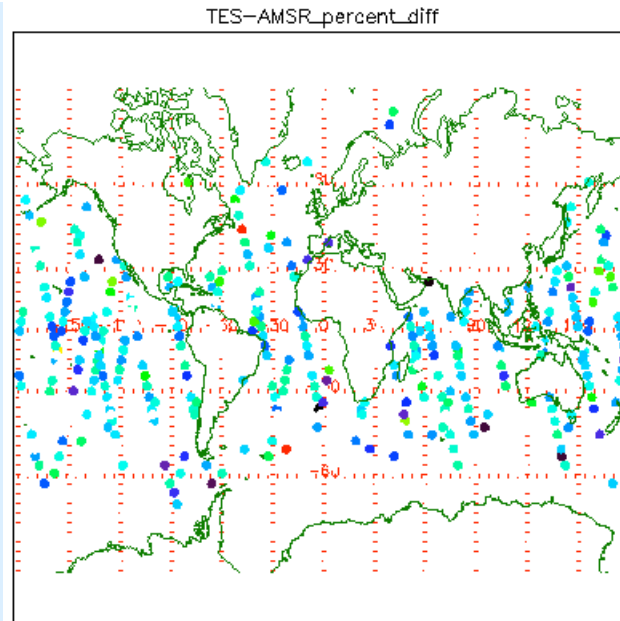
- TES
  - Global surveys
  - Step and stares
  - Removed data with radiance residual RMS larger than 1.4 or radiance residual mean greater than 0.1
- AMSR-E
  - V4 total water vapor product
- AIRS data
  - Closest match to TES, but note that retrievals are on 45km diameter footprint
  - Used only QA\_TEMP\_BOT =0
  - Using v4.0
- MLS data
  - V1.51
  - Did not apply QA screening

# The analysis

- Maps of total water and histograms of differences
- Scatterplots for each layer water
- Histograms and statistics of the differences
- Plots of bias and rms as a function of pressure

# AMSR-E

- TES is about 10% drier than AMSR-E total water vapor column.
- Differences are not latitudinally dependent.
- Similar statistics vs AIRS total water vapor.



TES-AMSR\_percent\_diff 2328  
data exceeds \*\*\*\*\* in 0019 cases  
data exceeds \*\*\*\*\* in 0006 cases  
data exceeds \*\*\*\*\* in 0003 cases  
data exceeds \*\*\*\*\* in 0002 cases

50.00 mean -9.391  
41.67 std dev 14.865  
33.33  
25.00  
16.67 min -80.593  
8.33  
0.00  
-8.33 max 65.813  
\*\*\*\*\* no\_pts 305.000  
\*\*\*\*\*

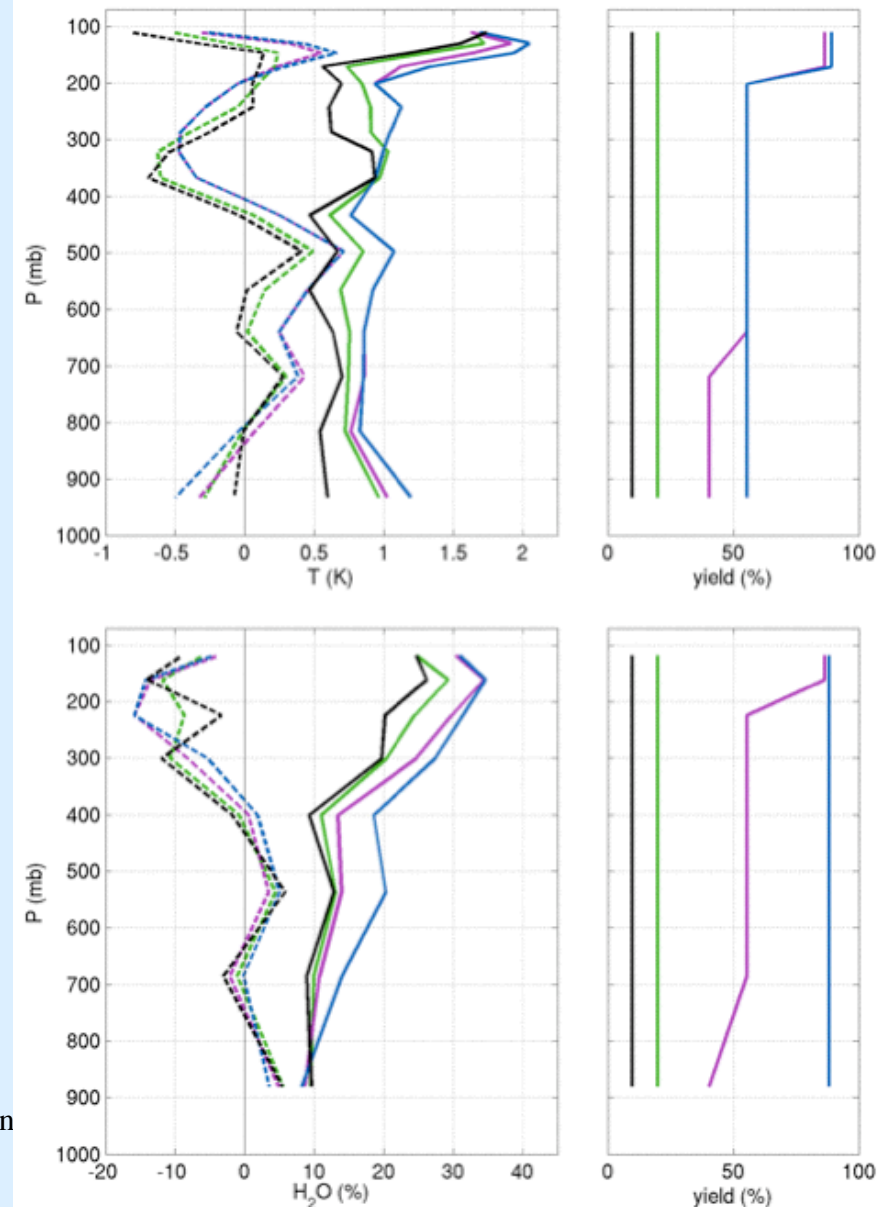
# AIRS & TES Comparisons

- Comparisons:
  - Integrated TES water vapor profiles to make a layer water quantity like AIRS 28 layer product
- Caveats:
  - Footprint:
    - AIRS retrievals are on a group of 9 AIRS footprints which are captured in an AMSU footprint - 45km diameter circle
    - TES retrieval is on 5km by 8km footprint
- Retrievals:
  - AIRS applies cloud-clearing and then a complex cascade of retrieval steps, including tuning
  - Different initial guesses, AIRS applies trapezoids to set the retrieval grid
  - AIRS incorporates microwave sounder measurements in retrieval
- Bottom line: I don't try to account for these differences, just note that they will impact comparisons

# AIRS v4 vs sondes

- Validation of AIRS version 4 retrievals using ARM TWP RH90 data scaled by MWR.
- Left upper panel: 1 km layer temperature differences (AIRS-ARM);
- Left lower panel: percent difference in 2 km layer water vapor amounts ( $100(\text{AIRS-ARM})/\text{ARM}$ );
- Right panels: yields using different quality constraints.

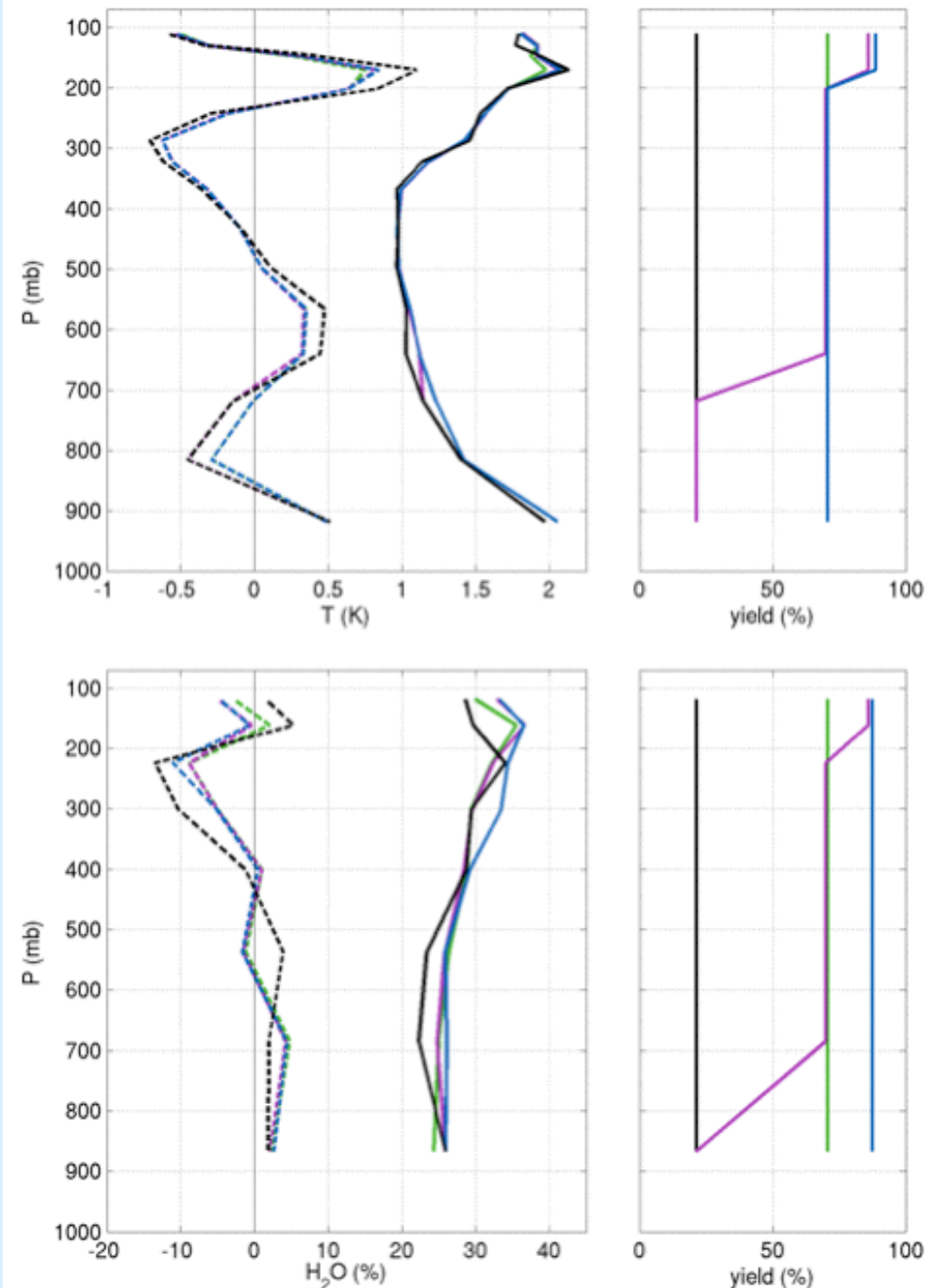
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# SGP

- Water vapor biases similar to TWP
- Larger rms differences at SGP due to weather conditions
- Analysis courtesy of Dave Tobin

Eldering -

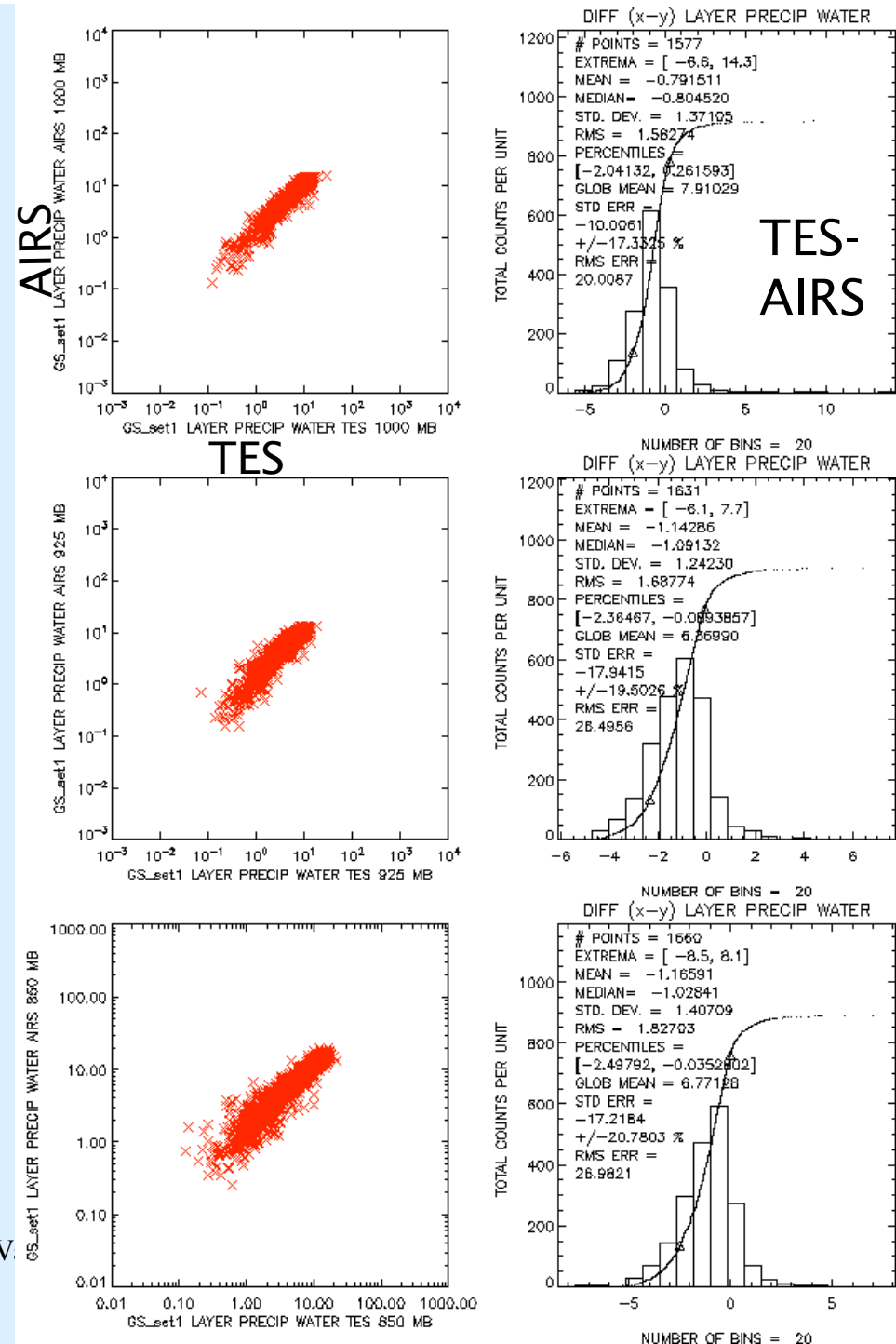




# Layer by layer analysis

- Most of column difference explained by near surface layers
- Mean difference are: -10%, -18%, and -17% at 1000, 925, and 800 mb.
- Standard deviation is about 20% at all these levels.

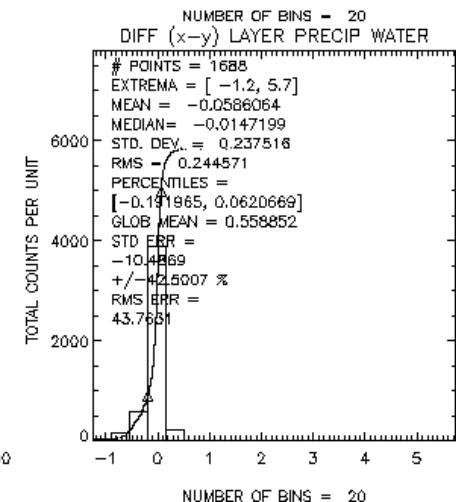
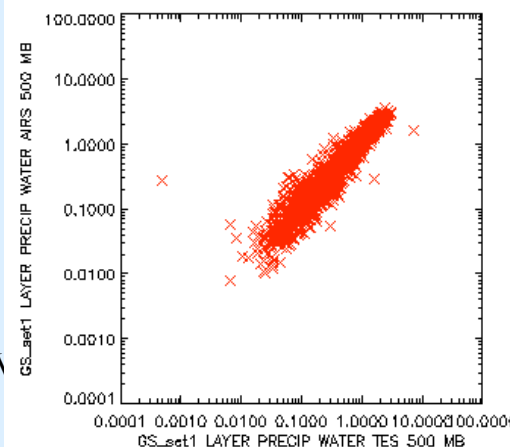
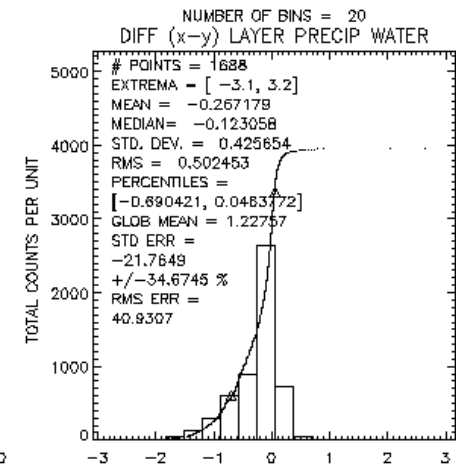
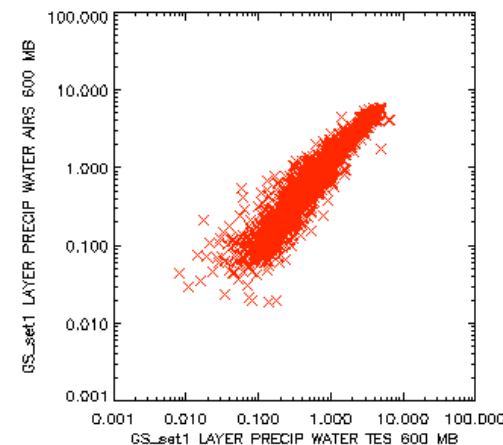
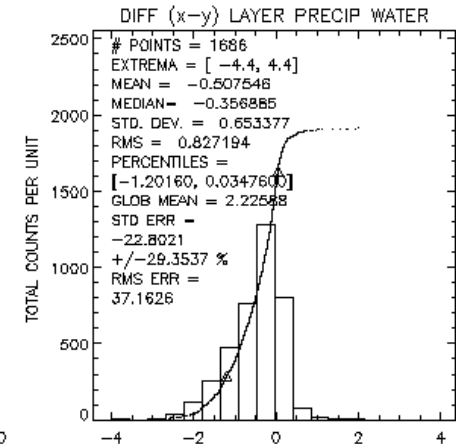
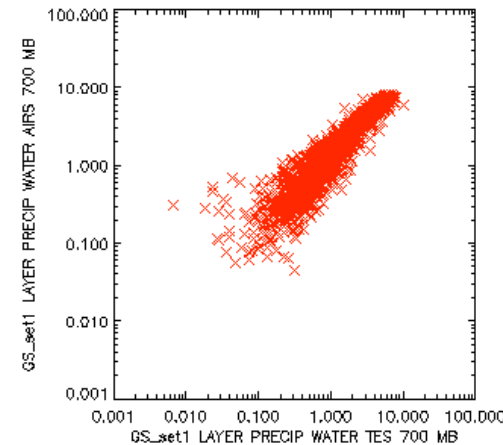
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# middle layers

- 700, 600, and 500mb layers, mean differences of -23%, -24%, and -10%
- Standard deviation close to 40%
- Histogram of differences is skewed

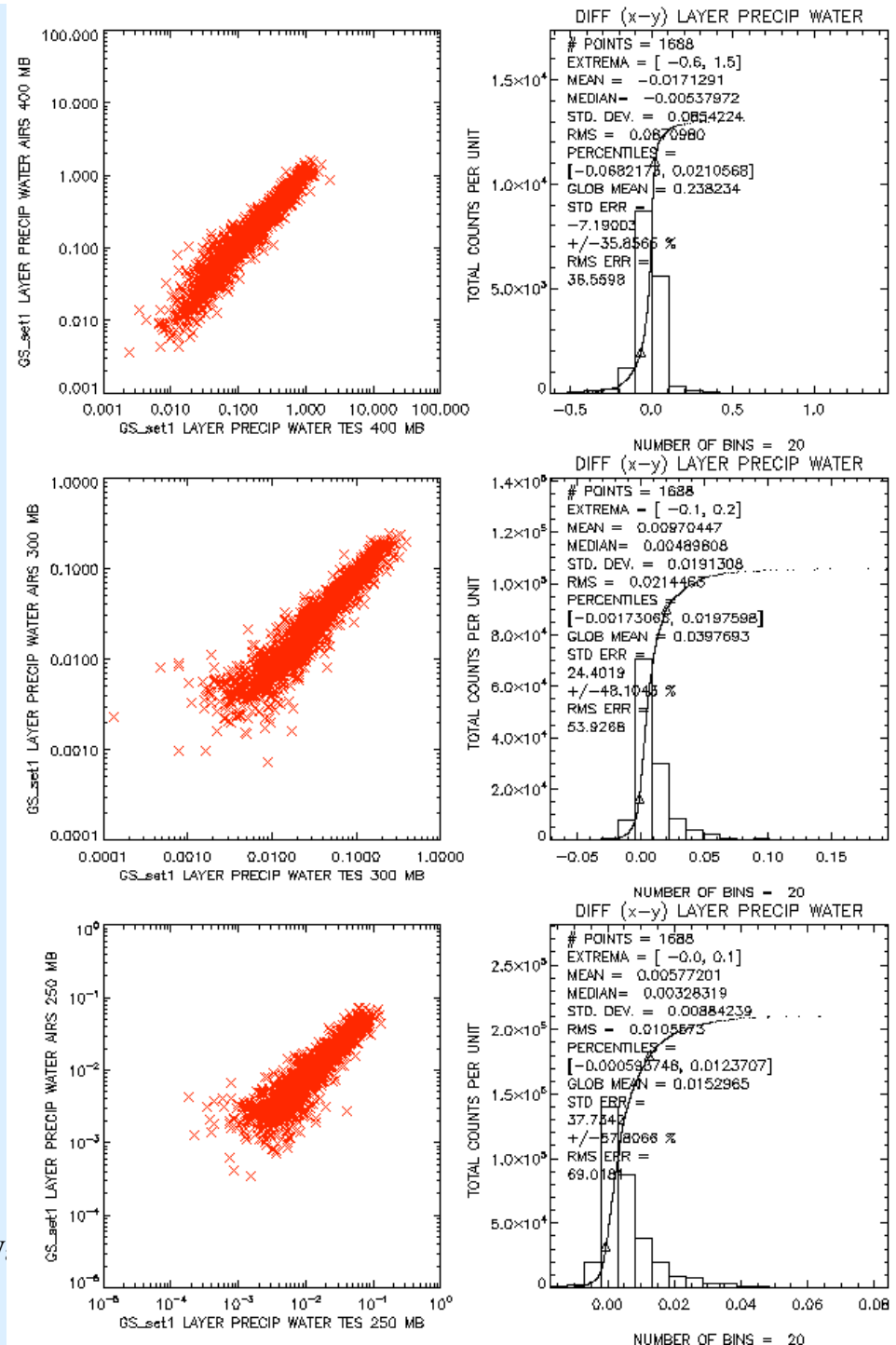
Eldering - Aura \



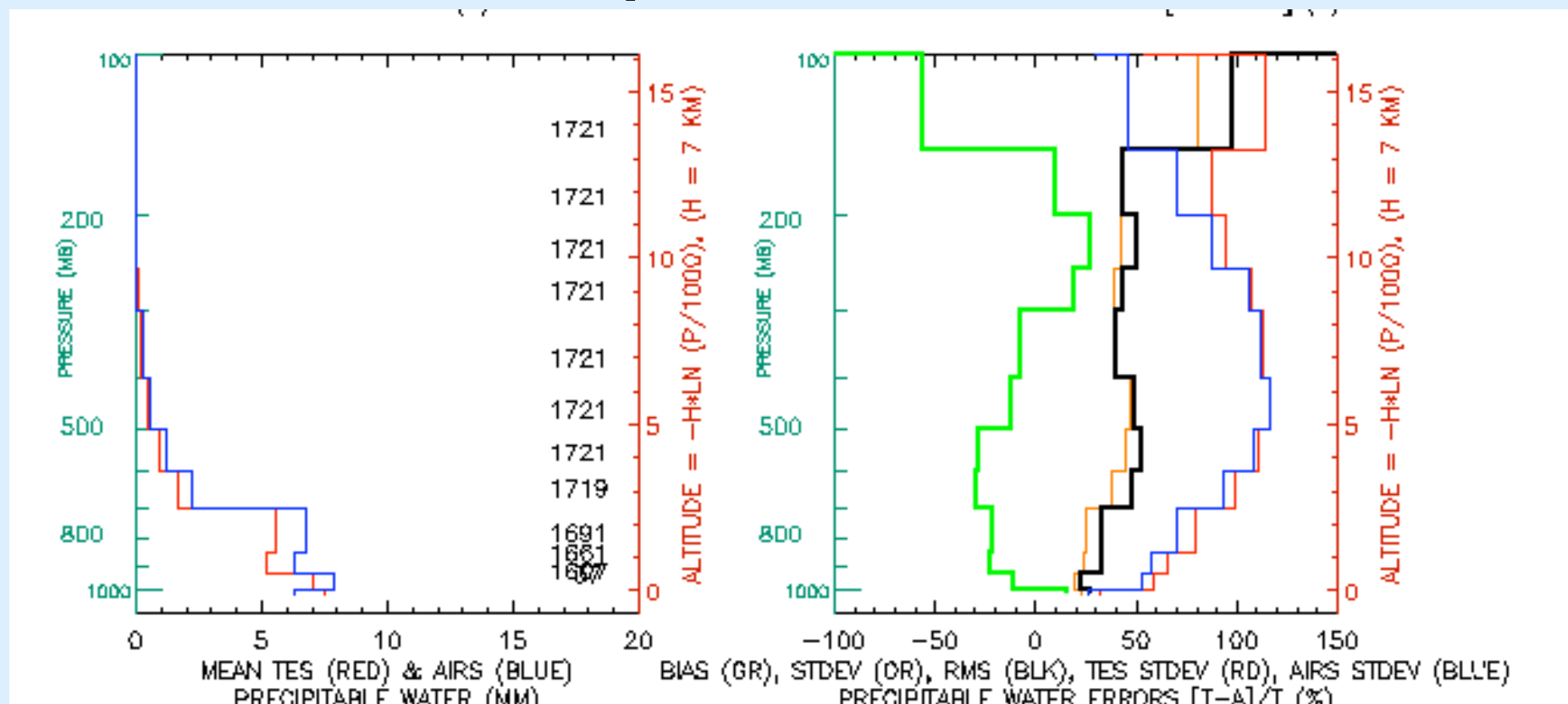
# highest altitudes

- TES becomes wetter than AIRS at these layers - 24% mean difference at 300mb.
- See a lot of scatter at low water vapor concentrations
- AIRS is about 10% drier than sondes at these altitudes.

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# A summary of statistics (GS)

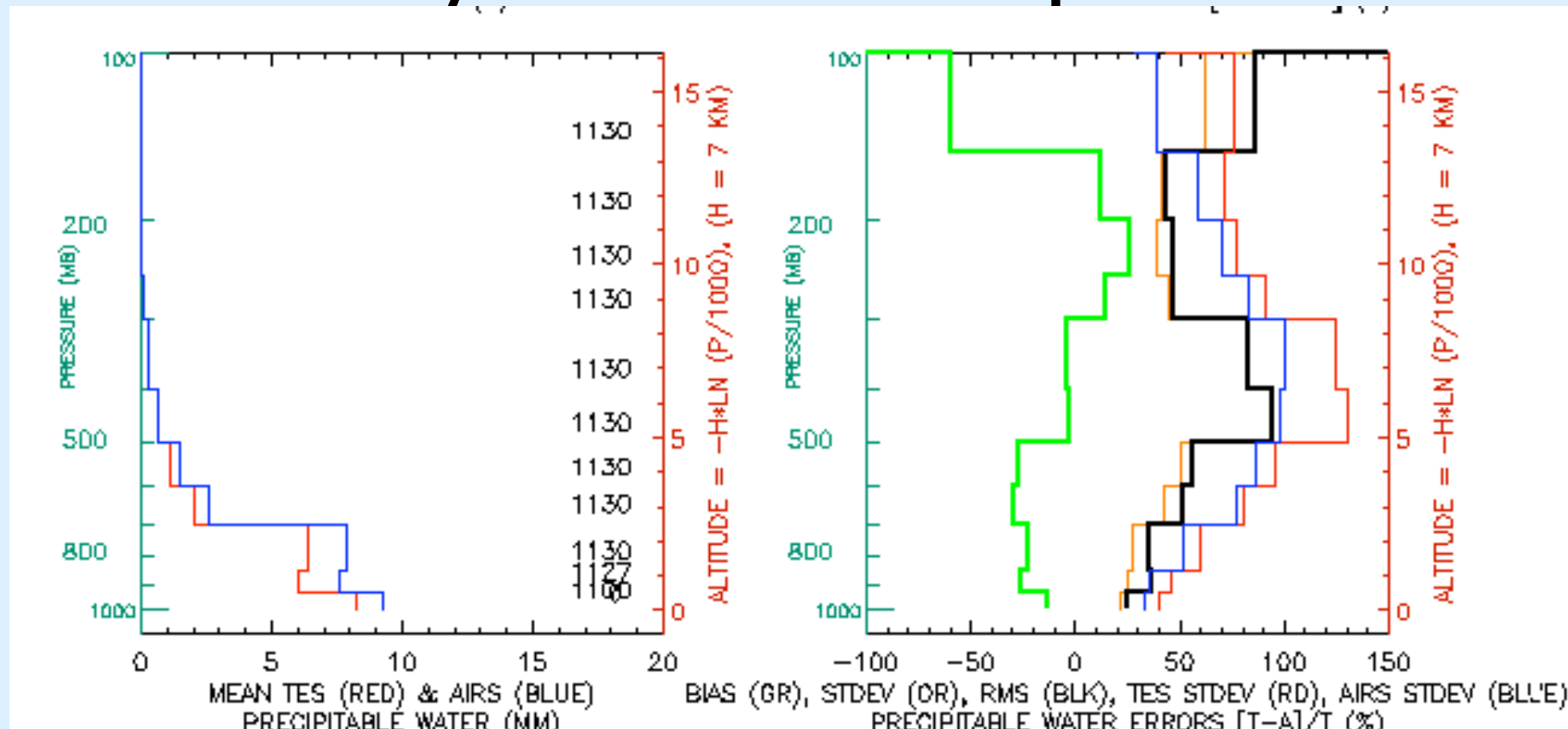


Mean profiles

TES - AIRS

Bias in green ( $[TES-AIRS]/TES$ ),  
rms differences in black

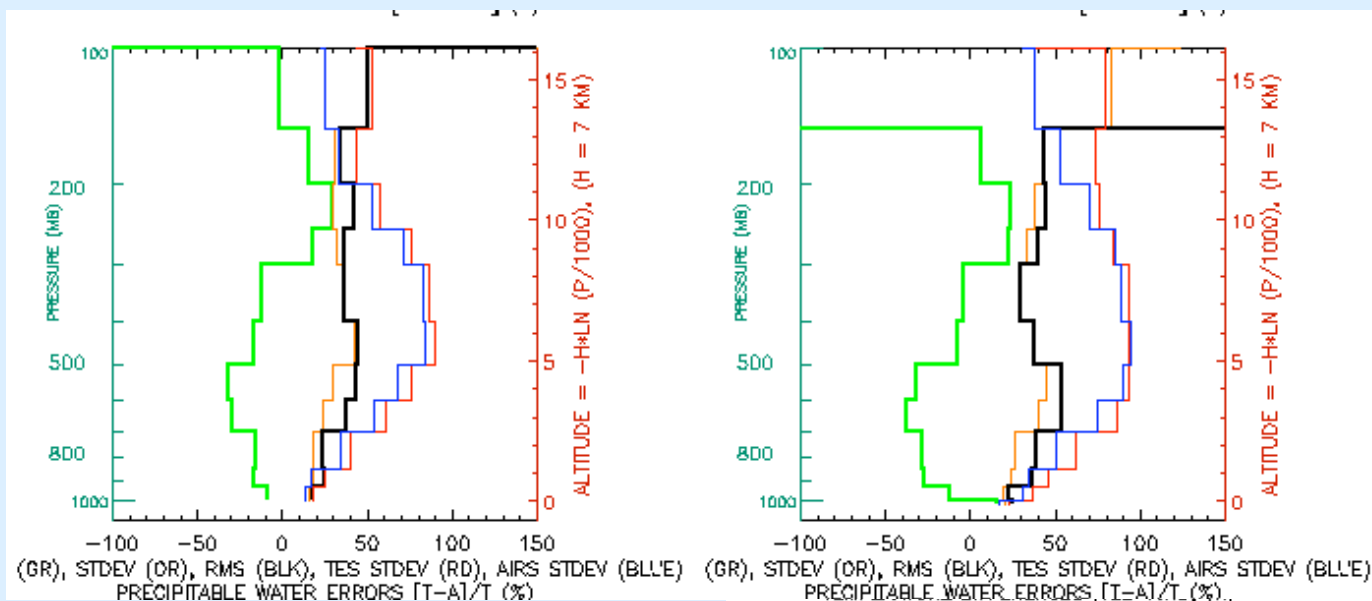
# Summary stats for step and stares



Similar statistics for special observations

# Latitudinal dependence?

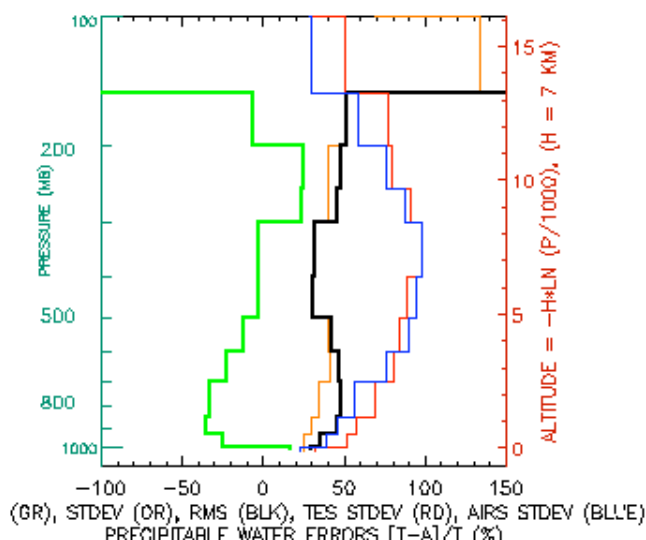
20S-  
20N  
555



20-40  
560

Overall characteristics  
of bias show little  
latitudinal dependence  
- bias becomes larger  
near colder surfaces

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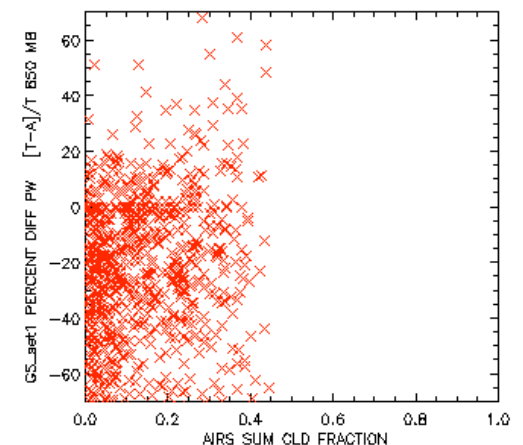
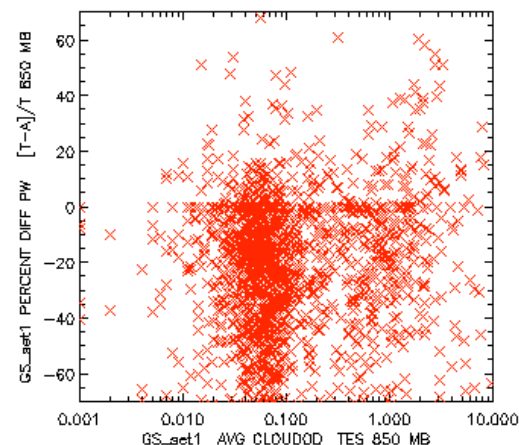
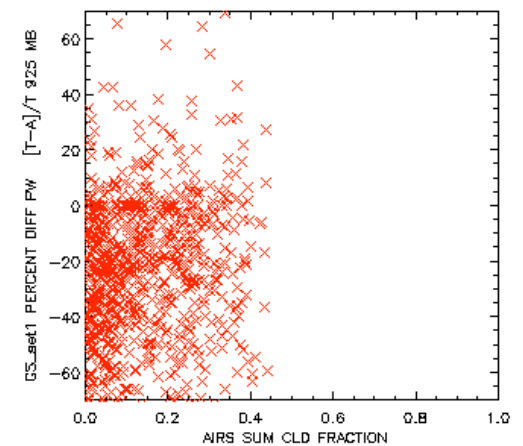
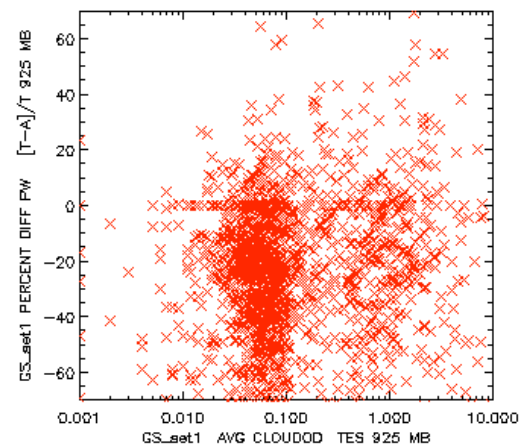
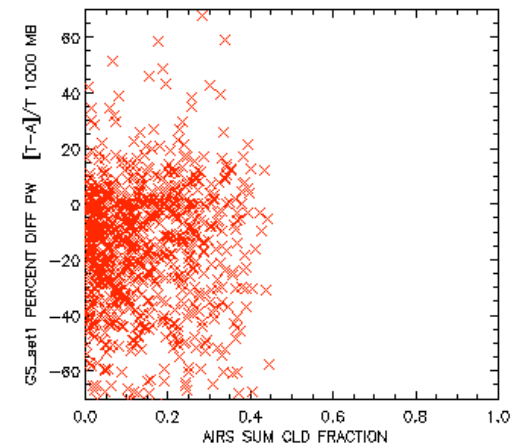
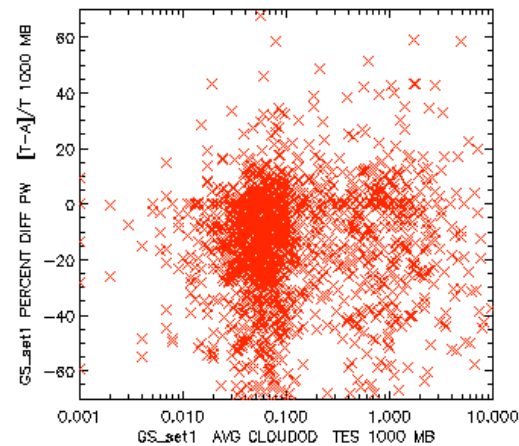


40-60  
400

# Difference vs optical depth

- Bias in water vapor is not correlated to cloud optical depth or fraction
- This holds true at all the layers examined

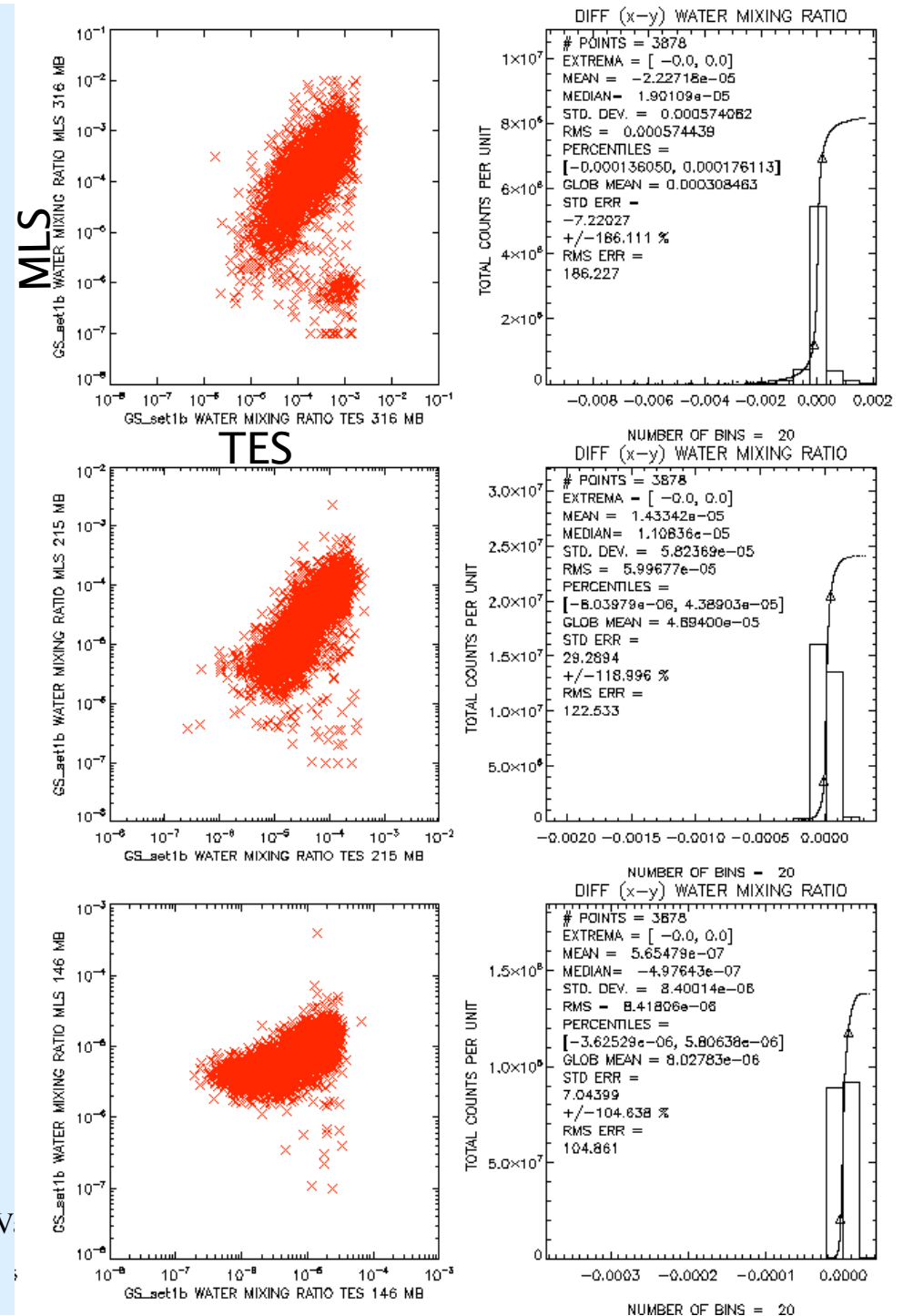
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# TES and MLS

- MLS data unscreened
- TES 7% wetter than MLS at 316mb
- TES 30% wet at 215mb
- TES 7% wet at 146
- Horizontal inhomogeneity as well as vertical sensitivity contribute to differences.

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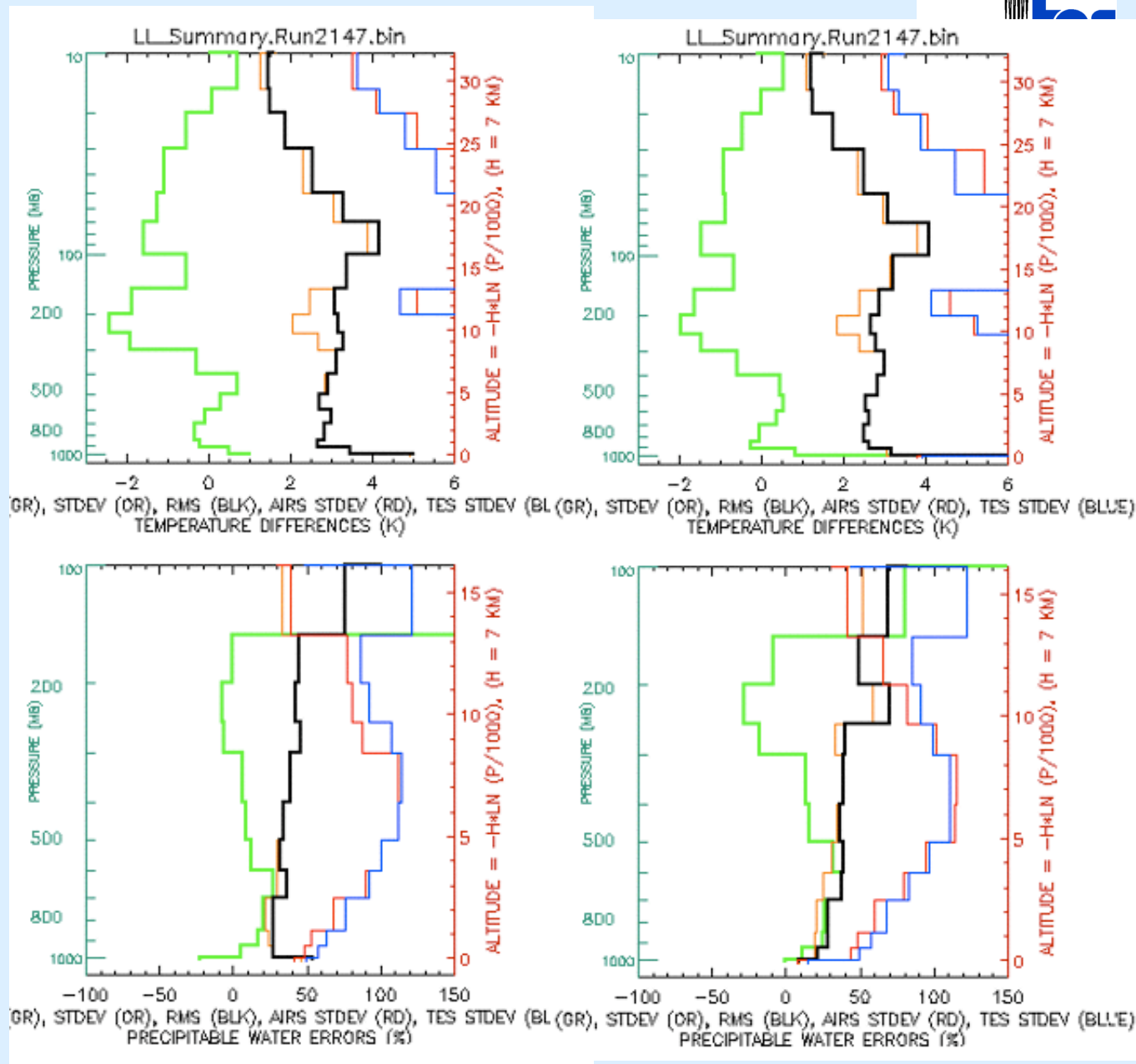
# Conclusions

- TES water vapor column is about 10% drier than AMSR-E and AIRS.
- TES drier than AIRS near from 900 to 500mb, TES is wetter than AIRS from 300-100mb.
- Statistics are similar at all latitudes, for global surveys and special observations.
- MLS comparison consistent with AIRS comparisons.
- AIRS and AMSR-E incorporate microwave sounder information - may explain column and near surface differences.
- Will compare TES to operational sondes to explore this issue.

# Backup slides

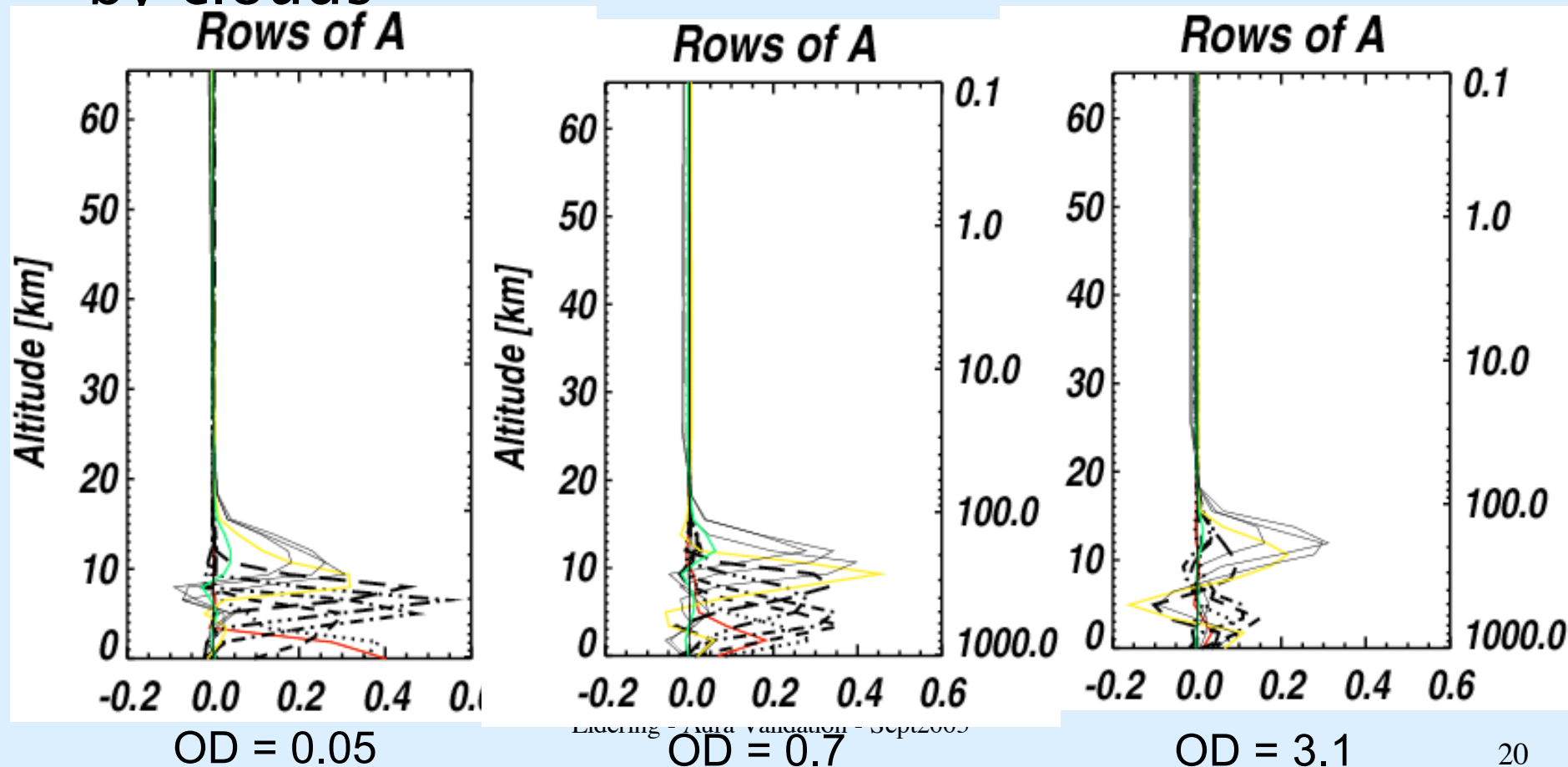
# 2147 versus AIRS v3(L) and v4 (R)

Since AIRS  
gets drier in  
upper trop in  
V4, bias  
becomes  
larger.



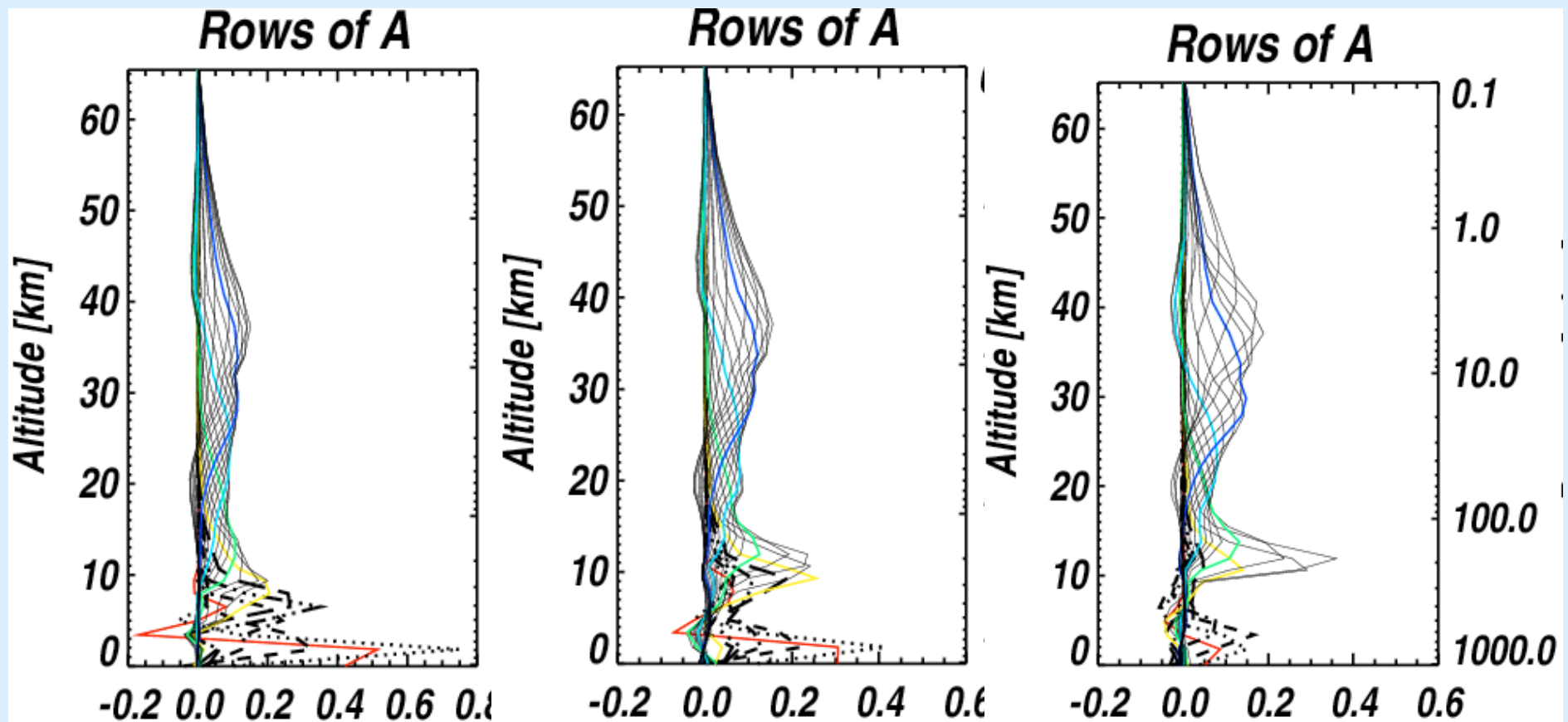
# TES Averaging kernels - water

- TES loses sensitivity above 200mb, impacted by clouds



# TES Averaging kernels - temperature

- Sensitivity throughout the atmosphere



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